PALM LEAVES REINFORCED CALCIUM CARBONATE/ADHESIVE/POLYALUMINIUM CHLORIDE AS A POTENTIAL ROOFING MATERIAL

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To my beloved mother, father and all family members

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ABSTRACT

Composites of adhesive/ calcium carbonate/polyaluminium chloride-PAC/ based waste material reinforced with oil palm leaves fibers have been prepared. Roofing components were produced with these composites through a simple and low-energy consuming method. Plant fibers, which are widely available in most developing countries, can be used as convenient materials for brittle matrix reinforcement, even though they present relatively poor durability performance. Taking into account the fibers mechanical properties, with an adequate mix design, it is possible to develop a material with suitable properties for building purposes. In order to improve the durability of plant fibers (oil palm leaves fiber), this paper presents the approach adopted in the research which is directed towards the development of alternative binders, with controlled free waste (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC). Palm leaves fibers demonstrate to be more suitable plant fibers for the reinforcement of large components as can be proved by in-use durability performance and several tests. More recently, pulp from eucalyptus waste and residual sisal and coir fibers have been studied as a replacement for asbestos in roofing components. The result has shown 10wt% of fiber is the optimal loading for composites where its characteristics quite satisfy and further loading beyond the level has caused an adverse result on the properties.

ABSTRAK

Bahan komposit terdiri daripada Perekat/ Kalsium karbonat/ Polialumnium klorida-PAC/ ditetulangkan gentian daun kelapa sawit akan ditunjukkan. Komponen pembumbungan dihasilkan dengan bahan komposit ini melalui satu kaedah penggunaan cara yang mudah dan menjimatkan tenaga. Serat/gentian tumbuhan yang mana boleh didapati secara meluas di kebanyakkan negara-negara membangun, boleh digunakan sebagai bahan yang sesuai/selesa untuk penulangan matrik yang rapuh, walaupun ia menonjolkan persembahan sifat yang lemah dalam ketahanan. Bagi meningkatkan ketahanan serat tumbuhan (serat daun kelapa sawit), tesis ini mempersembahkan pendekatan yang diambil dalam kajian di mana ia adalah diarah menuju peningkatan terhadap pengikat-pengikat alternatif, dengan kawalan ke atas sisa buangan bebas (Perekat/ Kalsium karbonat/ Polialumnium klorida-PAC). Gentian daun kelapa mendemonstrasi untuk menjadi serat/gentian tumbuhan yang lebih sesuai untuk penulangan terhadap komponen yang besar sebagaimana dibuktikan dengan persembahan ketahan yang untuk kegunaan dalam dan beberapa ujian. Lebih lagi kebelakangan ini, bahagian lembut daripada sisa buangan Eucalyptus dan lebihan serat Sisal serta sabut kelapa telah dikaji sebagai penggantian untuk asbestos dalam komponen perbumbungan. Keputusan yang ditunjukkan, 10 % berat serat adalah muatan optima untuk komposit sisa buangan di mana karektornya agak memuaskan dan muatan selanjutnya di sebalik tahap telah menyebabkan keputusan terbalik terhadap sifat-sifat tersebut.

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LIST OF SYMBOLS

Al_2O_3	-	Aluminium Trioxide
α	-	Coeficient of conductivity
B.C	-	Before Century
C	-	Carbon
$CaCO_3$	-	Calcium Carbonate
CaO	-	Carbon Monoxide
C_2H_4	-	Ethylene Monomer
$C_6H_{10}O_5$	-	Formula molecule of Cellulose
CO_2	-	Carbon Dioxide
$CO3^{2-}$	-	Carbonate Ion
Cr	-	Impact crack resistance Ratio
cm	-	centimeters
ft	-	feet
g	-	gram
g/cm^3	-	Density
H	-	Hydrogen
in	-	inch
Irs	-	Impact residual Strength
J/g	-	Unit for Enthalpy
K^w	-	Water Vapor Permeability
k_C	-	Thermal conductivity
kg	-	kilogram
kg/cm^2	-	Tensile strength at Yield
kJ/m^2	-	Unit for Izod Impact Strength
MPa / GPa	-	Unit for Tensile Strength and Young's Modulus
m	-	meter
min	-	minute

mm	-	milimeter
mm/min	-	Speed Rate
N	-	Newton (Load Cell)
O	-	Oxygen
ρ_C	-	Function of Density
psi	-	Atmospheric Pressure
r	-	Correlation of coefficient
seconds/cm	-	Absorption Rate
SiO_2	-	Silicone Oxide
T_m	-	Melting Temperature
Wd	-	Weight of Dry Waste
Ww	-	Weight of Wet Waste
xc	-	Gelation threshold.
^0C	-	Unit for temperature (Celcius)
^0F	-	Unit for temperature (Fahrenheit)
%	-	Percentage
%Mt	-	Percentage of Water Absorption
ΔH	-	Enthalpy
σ	-	Extent of Reactant

LIST OF ABBREVIATIONS

ASTM	-	American Standard of Testing and Materials
BFS	-	Blast Furnace Slag
CDW	-	Construction and Demolition Wastes
CFA	-	Chemical Foaming Agent
DPF	-	Date Palm Fibers
DSC	-	Differential Scanning Calorimeter
FRP	-	Fibre-Reinforced Polymer
FTIR	-	Fourier Transfer Infra-Red
HDPE	-	High Density Polyethylene
KBr	-	Kalium Bromide
LDPE	-	Low Density Polyethylene
LPE	-	Linear Polyethylene
MA-g-LLDPE	-	Maleated Anhydride grafting Linear Low Density Polyethylene
MFI	-	Melt Flow Index
MOR	-	Modulus of Rupture
OPC	-	Ordinary Portland Cement
PAC	-	Polyaluminium chloride
PP	-	Polypropylene
PSMA	-	Polystyrene Maleic Anhydride
PS	-	Polystyrene
NaOH	-	Natrium Hydroxide
uPVC	-	Unplasticizer PVC
UV	-	Ultra-Violet
WFRC	-	Wood Fiber Reinforced Cement
XRD	-	X-ray Diffraction

CHAPTER 1

INTRODUCTION

1.1 An Overview of the Study

The consumption of building components made with fiber reinforced cement increasing rapidly and nowadays in developed countries it is in the region of several million metric tonnes yearly. This occurs because it is possible to produce lightweight building components with this type of material, with good mechanical performance mainly impact energy absorption, suitable thermal-acoustic insulation and is economically feasible. Within the developing world, where the lack of housing and also of commercial, industrial and public service buildings is considerable, the introduction of these materials can help increase production of buildings with suitable performance. (Savastano Jr. *et al.,* 1999)

In these countries, plant fibers can be a good alternative due to low cost, as long as the low durability risks in an alkaline environment are eliminated. Besides, in some countries, asbestos cement is still the sole composite in use, although health hazards are increasingly causing concern. The main objective of this paper is to present the performance of roofing tiles made with polymer waste (Adhesive/

Calcium carbonate/ Polyaluminium chloride-PAC) reinforced with palm leaves fibers, following the research work already done for building partitions. (Savastano Jr. *et al.,* 1999)

1.2 Problem Statement

The ability of roof tiles to resist the attacks of a wet and freezing environment is of primary importance. Their other main qualities, for example strength, became secondary in a case where the roof tiles failing such an environment. For several years the appropriate connection among mechanical properties, resistance of roof tiles to physical corrosion and their pore size distributions have been developed, specifying particular methods of investigations. The phenomena of chemical deterioration of ceramic systems were not included in those considerations. The attack of water as well as of the acid gases on the ceramic systems has, however, a remarkable influence on their resistance. (Ranogajec *et al.,* 1997)

So do with the poor heat properties. The present research analyses these phenomena, which are very specific for systems with remarkable Pozzolanic character and fired clay materials, elucidating a wide range of new crystalline forms. The presences of CaO in ceramic systems (obtained after thermal decomposition of CaCO3) as well as its contact with water, in a specific environment, and the polluted atmosphere, are the main factors controlling the deterioration step of these systems. Some of these phenomena are known in the field of cement chemistry. Using this knowledge, particularly as for the formation of calcium silicate hydrate and ettringite phases, the factors controlling chemical corrosion and deterioration of roof tiles have been determined. (Ranogajec *et al.,* 1997)

The performance of a building's roof is the key to the integrity of the structure and the comfort and well being of the occupants. Roof failures run the

gamut from catastrophic structural failure from earthquakes, fire, snowstorms, tornadoes, and hurricanes to major leaks caused by falling tree limbs and the intrusion of wind-driven rain under roof shingles or tiles. Damage is also caused by deterioration of roof sheathing and saturation of insulation from ice damming and wind-blown moisture into attic spaces through soffit, gable-end, and ridge vents. Minor leaks due to improper caulking or flashing at roof penetrations, or roof/wall intersections are also common. However, this project does not recovered all failures and being upgrade completely. It just try to improve the basic properties such like thermal properties, water absorption and mechanical properties by use new type material fiber. (Winter *et al.,* 1999)

In order to discover what is the effect of palm leaves fiber as reinforcing agent with, polymer/ waste material (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC), several factors that influence and affect the properties of desired roof tile has to be considered .The best formulation , modification and effective processing condition parameters were investigated. Thus, the particular questions that have to be answered in this area of research are:

i.) What is the effect of roof tile to palm leaves fiber reinforcing polymer/waste (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC)
ii.) What are the effects of impact strength and maximum energy absorbed on waste roof tile product?
iii.) What is the effect of water absorption on waste roof tile product?
iv.) What is the effect of thermal properties on it?

Therefore, this project was try to produce new alternative roof tile with upgrade characteristic by enhance their structure like tensile and impact, have a good heat conductivity and low water absorption with low cost.

1.3 Objectives of the Study

The main objective of the study in this presentation paper is to determine the suitability of oil palm leaves reinforced polymer waste (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC) as roofing materials. This purpose can be divided into:

i) To study the effect of impact strength of oil palm leaves fiber compositions on the waste (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC)

ii) To investigate the effect of water absorption palm leaves fiber on the waste material (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC)

iii) To determine the thermal properties (heat conductivity) of palm leaves compositions on the waste (Adhesive/ Calcium carbonate/ Polyaluminium chloride-PAC)

1.4 Scope of Study

(a) Preparation of the Samples Formulation

To realize the objectives of this study, formulation of waste material, HDPE and palm leaves fibre is used as the matrix, binder and fibres respectively. Base on the formulation the following stages are involved:

i) Dry Blending
ii) Extrusion and Injection Moulding

(b) Properties Identifying

i) Spectroscopy test is applied by the analyses of Fourier transform infrared (FTIR) using Perkin-Elmer 1600 series instrument to prove characterize of elements consist in the product of the reaction.

ii) Izod-Impact strength test is carried out to establish average maximum impact strength, and energy absorbed at break of waste material/ HDPE/ oil palm leaves fibre blends using Toyoseki impact tester

iii) Gravimetrical analysis is utilized in order to employ the averages values of water absorption of waste material/ HDPE/ oil palm leaves fibre blends.

iv) Thermal conductivity test is employed to identify the averages values of heat conduction of waste material/ HDPE/ oil palm leaves fibre blends by using Mathis instrument